Northwestern | McCORMICK SCHOOL OF ENGINEERING

FALL 2016

MATERIALS SCIENCE AND ENGINEERING

ERIK LUIJTEN NAMED DEPARTMENT CHAIR

Luijten succeeded Michael Bedzyk on September 1

Erik Luijten, professor of materials science and engineering and of engineering sciences and applied mathematics, has been named the chair of the Department of Materials Science and Engineering at Northwestern's McCormick School of Engineering, effective September 1. Luijten succeeds chair and professor Michael Bedzyk.

"I want to thank **Mike Bedzyk** for his service to the department and the McCormick School," said Dean **Julio M. Ottino**. "Under his leadership, the department continued on an excellent trajectory and is poised for future success. I am confident that Erik will provide strong leadership as the department continues to stand as one of the very best of its kind in the world."

Over the past ten years, the Department of Materials Science and Engineering has added a number of new faculty at both the junior and senior levels. Its faculty members have led many University-wide initiatives and have been recognized with such honors such as membership in the National Academy of Sciences, a MacArthur Fellowship, Presidential Early Career Awards, and a Sloan Research Fellowship.

"The department represents a true realization of the type of interdisciplinary research that is close to my heart, and the faculty pursue it at a level that continues to impress me on a daily basis," Luijten said. "The department also stands out as a collegial and positive environment, making me honored to serve in this position. I am confident that we can grow in excellence in terms of both research and teaching."

With a courtesy appointment in physics and astronomy at the Weinberg College of Arts and Sciences, Luijten has directed Northwestern's Applied Physics Graduate Program. In his research group, the Computational Soft Matter Lab, he uses computer simulations to investigate the collective behavior in complex fluids and soft condensed-matter systems.

Before joining Northwestern in January 2009, Luijten was an associate professor at the University of Illinois at Urbana-Champaign. He received his master's degree in physics from Utrecht University and his PhD in physics from Delft University of Technology — both in the Netherlands — and then completed postdoctoral fellowships at the Max Planck Institute for Polymer Research, the University of Mainz in Germany, and the University of Maryland.

Luijten

> "THE DEPARTMENT REPRESENTS A TRUE REALIZATION OF THE TYPE OF INTERDISCIPLINARY RESEARCH THAT IS CLOSE TO MY HEART."
>
> ERIK LUIJTEN

FROM THE CHAIR

Dear Friends,

I offer my first hello as department chair. Since I began the position on September 1, it's been a whirlwind, with many exciting things to learn.

I would like to start by thanking **Mike Bedzyk** for his strong leadership over the past five years. He has done much to advance the department, with initiatives ranging from the spring alumni celebration to the creation of new space for graduate students, and notably growing the department through the hiring of several new faculty members. With help from **Kathy Faber**, Mike established the Johannes and Julia Randall Weertman Graduate Fellowship, with has reached $900,000 to date. This fellowship recognizes our most outstanding students and honors two of our most respected and beloved faculty.

In September, we welcomed bioelectronics pioneer **John Rogers** as the Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering, and Neurological Surgery. John will lead the new Center for Bio-Integrated Electronics which will be housed in the new Simpson Querrey Institute for BioNanotechnology on the Chicago campus. I am also excited to announce that **Kathleen Stair** has been promoted to professor of instruction. Most of you know that Kathleen plays a central role in our department, so we are truly happy that she is recognized and rewarded.

Among many events this fall, we were pleased to host Charlie Kuehmann (PhD '94, Olson), vice president at Tesla and SpaceX (see page 5). His lecture drew an audience that filled the Tech's Ryan Auditorium.

A department that so brims with activity can only operate smoothly with a great support system. Since July we have a new business administrator, **Alice Camacho**, who previously managed research administration at Feinberg. We also welcomed **Shirley Bar-Meir**, our new accounting specialist, who joins us with accounting experience in an elementary school and university setting. We are enthusiastic to have them both join the team.

Of course, the quest to expand our department's activities also means that we continue to try to optimize our use of space. As Mike mentioned in earlier newsletters, the Seeley-Mudd Library is being transformed to house a variety of research labs and office spaces, including some for our department. Presently, we are renovating the main office area, which will create 14 additional office spaces for graduate students.

On pages 4 and 5, we highlight recent global interactions initiated by our faculty and students. Our faculty, students, and alumni continue to be recognized for their accomplishments and leadership. Many of these are listed in the news section on page 7. Warm congratulations to all! It makes me proud and excited to serve such an accomplished materials science and engineering family.

Erik Luijten
Department Chair

CONTRIBUTIONS

MATERIALS SCIENCE AND ENGINEERING

Zachary Richard Patterson
Tao Sun, PhD and Wei Zhang, PhD
Ms. Samantha Christine Cruz
Ms. Zhou Lu

JOHANNES AND JULIA RANDALL WEERTMAN GRADUATE FELLOWSHIP FUND

Prof. Katherine T. Faber and Mr. Thomas F. Rosenbaum
Jeffrey T. Gotro, PhD and Mrs. Elaine M. Grossman-Gotro
Rong-Tsang Chen, PhD
Mrs. Joanna H. Gwinn and Donald G. Gwinn, PhD

MORRIS E. FINE LECTURE

Anil Virkar, PhD

Donations made between October 6, 2015 and April 27, 2016. If you would like to contribute to MSE funds, please contact Patrick Hankey at patrick.hankey@northwestern.edu.

Congratulations, Graduates!

Congratulations to Northwestern's materials science and engineering Class of 2016. From left: Yifan Sun, Yang Yu, Kerem Taskin, Theo Gao, Norman Luu, Peter Kim, Zhou (Angelina) Lu, Kelly Hyland, Nicholas Geisendorfer, Elad Deiss-Yehiely, Elizabeth Steele, Yu-Wei (Alex) Lin, Rebecca Glaser, Martin Hewitt, Lu (Jamie) Chen, Christopher Lee, Brian Zhang, Vassilis Roussochatzakis, Matthew Ocana, Luqman Azhari, Shu Funato, Danielle Butts, Christina Robinson, Robert (Jack) Cavanaugh. Missing: Ritij Goel, Kwang Ho Roh, Ruijing (Hazel) Yan, and Evan Armet.

NORTHWESTERN EXPERIMENTS HEAD TO SPACE

Dunand, Voorhees receive NASA funding to put experiments on the International Space Station

Two Northwestern Engineering experiments will soon take up residence inside of a galactic laboratory.

NASA's Physical Science Research Program is funding 16 flight proposals for research to be conducted aboard the International Space Station as a part of its MaterialsLab program. Professors **David Dunand** and **Peter Voorhees** are among those funded.

"This is exciting news for Northwestern Engineering," Dunand said. "Only sixteen projects were selected nationwide from a very large pool, and we received two of them."

Dunand and Voorhees co-advise a project that creates foams made of titanium oxide and other ceramics through a process called freeze casting. When titanium oxide nanoparticles are suspended in water and frozen, the ice crystals push the nanoparticles into regions where they are concentrated. The ice crystals are then removed by sublimation, leaving behind a highly porous nanoparticle scaffold, which can be further consolidated by heat treatment. The freeze casting process benefits from zero gravity as the resulting structures are more regular than those created in the laboratory.

Voorhees' funded experiment will examine fragmentation that occurs during the solidification of a metal. Fragments are one of the major defects in metal castings and, for example, can greatly reduce mechanical properties of turbine blades used in jet turbines and wind turbines. Performing the experiments in reduced gravity prevents fragments from settling, making it possible to measure the location and rate at which these fragments form.

Dunand

Voorhees

"This will help us understand the fragmentation process and build models to predict when these fragments may form during solidification on Earth," Voorhees said. "These models can then be used to prevent fragmentation during solidification of turbine blades and other castings on Earth."

Workshop on Visual Representation of Research

Researchers participated in the June workshops

Scientific graphics often pack a one-two punch. Visualization not only helps to communicate scientists' results, but it can also give them new insight into their own work. Supported by the Barry and Mary Ann McLean Fund for Art and Engineering through the McCormick Dean's office, Professor **Jiaxing Huang** organized a hands-on workshop in June for McCormick researchers called "Visual Representation of Research."

Science photographer Felice Frankel, a research scientist in the Center of Materials Science and Engineering at the Massachusetts Institute of Technology and co-author of Visual Strategies, taught the workshop. A Guggenheim fellow, Frankel promotes the public understanding of science through visual expression. She was the principal investigator of the National Science Foundation-funded program "Picturing to Learn," which studied how visualization aids teaching and learning.

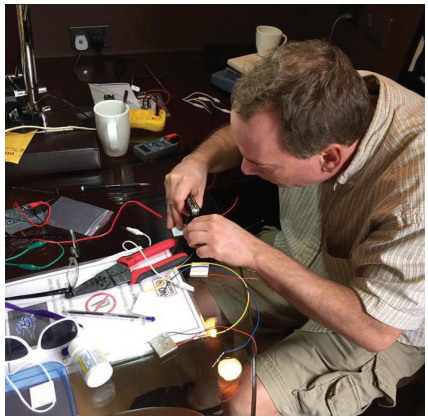
Participants work on images that illustrate their research.

GLOBE TROTTING

Workshops and research opportunities abroad have provided many materials science and engineering students and faculty with the opportunity to travel, host visitors, and gain global perspectives on their research.

TANZANIA

From May 29 to June 10, graduate students **Riley Hanus**, **Anu Kahn**, and **Justin Railsback** were among the 25 US and 40 African students participating in the Joint Undertaking for an African Materials Institute (JUAMI 2016) in Arusha, Tanzania. Northwestern faculty participants from the Department of Materials Science and Engineering included Professors **Scott Barnett**, **Sossina Haile**, **Teri Odom**, and **Jeffrey Snyder**. The institute included an intensive two-week course with lectures, hands-on learning, and research seminars related to renewable energy, as well as the opportunity for cross-cultural exchange. Extracurricular activities included hiking in Arusha National Park, a safari in Tarangire National Park, and a visit to the Nelson Mandela African Institution of Science and Technology. JUAMI 2016 was funded primarily by a grant from the US National Science Foundation proposed by Haile, Simon Billinge of Columbia University, and Peter Green of the University of Michigan. Additional funding was provided by the Office for Global Initiatives. The MRS Foundation is supporting follow-up collaborations.



Top: Students visit Arusha National Park. Bottom: Professor Jeffrey Snyder assembles a hands-on project for the students.

NETHERLANDS

Students tour a painting conservation lab.

PhD student **Lindsay Oakley** (Shull) spent eight weeks in the Netherlands using molecular dynamics simulations of an oil paint model system to determine the glass transition temperature and diffusion constants for gases and solvents in the system. The model can be used to determine how conservation interventions or environmental conditions might influence aging oil paint. The project was part of the US-Netherlands international research experience program funded by a grant from the National Science Foundation and administered through the Northwestern University/ Art Institute of Chicago Center for Scientific Studies in the Arts (NU-ACCESS) program.

Four US-based graduate students and one undergraduate student conducted research in cultural heritage science in the Netherlands from June to July. Students spent time at the Atelier Building (Ateliergebouw), a core facility that houses laboratories dedicated to research into cultural heritage, the University of Amsterdam, the Rijksmuseum, the scientific research arm of the Cultural Heritage Agency of the Netherlands, the Delft University of Technology, and the Netherlands Forensic Institute. The program was coordinated by **Marc Walton**, senior scientist at the NU-ACCESS, **Francesca Casadio**, co-director of NU-ACCESS and head of conservation science at the Art Institute of Chicago, and Professor **Kenneth Shull**, who has collaborated with the Art Institute of Chicago for several years to study rheological properties of paint systems.

ISRAEL

The second Northwestern University/Tel Aviv workshop was held September 20-22, 2016 at Northwestern University, focusing on the themes energy, sustainability, and biomaterials, and a sub-theme on water and materials. The first joint workshop was held at Tel Aviv University in February 2015. Seventeen attendees from Tel Aviv University and 19 attendees from Northwestern delivered presentations. These joint workshops, organized by Northwestern's Professor **David Seidman** and Tel Aviv University's Noam Eliaz, are designed to foster collaborations between researchers in materials science and engineering at the two institutions. In addition to research presentations and laboratory tours, the workshop included a Chicago River architecture boat cruise. Learn more at mccormick.northwestern.edu/nu-tau-workshop.

Top: Workshop co-chair David Seidman mingles with guests at the event's closing reception; Above: Tel Aviv University's Tal Dvir presents his work on cardiac tissue engineering. Dvir was just one researcher to present research during the three-day event.

Students suit up for a tour of a salt mine in Berchtesgaden.

GERMANY

Nick Geisendorfer and **Rebecca Glaser** (both MSE '16) were among seven students from Northwestern and the University of Texas at San Antonio who participated in Nanomaterials Undergraduate Research in Germany (NanoRING) this summer. The summer research programs were sponsored by the National Science Foundation, Electronic Materials Gateway Network, and the Alexander von Humboldt Association. The students spent 8 to 10 weeks at the Technical University of Munich where they researched the electrospinning of polyethylene fibers for solid-state batteries and the optimization of lithium-ion batteries. Students also had an on-site orientation with survival German and participated in science and technology workshops and cultural and social outings. The program was coordinated by Northwestern's Materials Research Center and **Matthew Grayson**, associate professor of electrical engineering.

MSE Welcomes Charlie Kuehmann

The Materials Science Umbrella Society hosted MSE alumnus **Charlie Kuehmann** (PhD '94) on October 13. The vice president of materials engineering at SpaceX and Tesla Motors, Kuehmann was the inaugural speaker of the MSE Prominent Alumni Speaker Series. Here he stands with Materials Science Umbrella Society officers Bor-Rong Chen, Shengshuang Zhu, Qingyuan Lin, and Gavin Campbell.

DEPARTMENT CELEBRATES ITS RECENT PHD GRADUATES

The Department of Materials Science and Engineering celebrates its PhD candidates who graduated between December 2015 and August 2016. They are listed below with their current job placements.

Ashwin Shahani, seen here with Professor Yip-Wah Chung after winning the AVS Award at the 2016 Hilliard Symposium, will join the University of Michigan as an assistant professor.

Kenneth D'Aquila (Petford-Long), adjunct professor of physics at Oakton Community College

Heather Arnold (Hersam), process engineer at Intel Corp.

Muratahan Aykol (Wolverton), postdoctoral fellow at Berkeley Lab

Peter Bocchini (Dunand) materials, process, and physics engineer at Boeing

Thomas Cool (Voorhees), postdoctoral fellow at Northwestern University.

Jeffrey Doak (Wolverton), materials design engineer at QuesTek Innovations, LLC

Alexander Dolgonos (Chang), process and technology development engineer at Intel Corp.

Dana Frankel (Olson), materials design engineering at QuesTek Innovations, LLC

Michael Geier (Hersam), storage engineer at InVenergy

Matthew Glazer (Dunand), battery and materials scientist at Exponent

Peijun Guo (Chang), postdoctoral fellow at Argonne National Laboratory

Sarah Howell (Lauhon)

Yi Hua (Odom), senior process engineer at Intel Corp.

Deep Jariwala (Hersam), postdoctoral fellow at CalTech

Hunter Karmel (Hersam)

David Kennouche (Barnett), research scientist at Forschungszentrum Jülich

Brian Kiraly (Hersam), postdoctoral fellow at Radboud University

Ricardo Komai (Olson), materials design engineer at QuesTek Innovations, LLC

Tian Lan (Torkelson), senior engineer at The Dow Chemical Company

Ting Li (Olvera de la Cruz), data engineer at Jump Trading, LLC

Zhao Liu (Barnett), CMP engineer at Cabot Microelectronics

Kevin McReynolds (Voorhees), postdoctoral associateship at the National Research Council

Elizabeth Martin (Shull), senior scientists at Abbott

Elizabeth Miller (Barnett), postdoctoral fellow at Stanford Synchrotron Radiation Lightsource

Sarah Miller (Faber)

Ashley Paz y Puentes (Dunand), assistant professor at the University of Cincinnati

Michael Rawlings (Dunand), postdoctoral fellow at Northwestern

Jung Woo Seo (Hersam), fabrication research engineer at Nanoelectronics

Ashwin Shahani (Voorhees), assistant professor at the University of Michigan

Tejas Shastry (Hersam), lead data scientist at GreenKey

Alexander Smith (Huang), senior reliability engineering at Apple

David Snydacker (Wolverton), CEO of Lilac Solutions and battery consultant at Dosima Research

Lauren Sturdy (Shull), materials engineer at Naval Air Warfare Center

Anthony Tan (Torkelson), senior product development chemist at The Dow Chemical Company

Faifan Tantakitti (Stuff), lecturer at Chiang Mai University in Thailand

Nicholas Wengrenovich (Olson), senior steels engineering at Pratt & Whitney

Ankun Yang (Odom), postdoctoral fellow at Stanford University

Kun Ho Yoon (Lauhon), senior process engineer at Intel Corp.

Yu Zhou (Mirkin), software engineer at Facebook

Hilliard Symposium 2016

The 29th annual Hilliard Symposium, organized by Professor **Yip-Wah Chung**, was held on May 19 at Northwestern's Norris University Center. Intel's **Carolyn Duran** (PhD '98, Wessels) delivered the keynote address, "Redefining What We Mean by a Quality Product."

SPEAKERS

1ST PLACE AVS AWARD
Ashwin Shahani (Voorhees) *"Watching the Evolution of Highly Anisotropic Microstructures"*

2ND PLACE
Nikhita Mansukhani (Hersam) *"High Concentration Aqueous Dispersions of 2D Nanomaterials for Toxicity and Environmental Fate Testing"*

3RD PLACE (TIE)
Nari Jeon (Lauhon) *"Evolution of Nanoscale Composition in Nonplanar Heterostructures;"* **Ankun Yang** (Odom) *"Plasmonic nanocavity arrays for directional and tunable lasing"*

Peijun Guo (Chang) *"Ultrafast switching of infrared plasmons in ITO nanorod arrays"*

Sarah Howell (Lauhon) *"Characterization and Modeling of Hybrid Van der Waals Optoelectronic Devices"*

Brian Kiraly (Hersam) *"Directional Graphene Nanoribbon Synthesis"*

Ashley Paz y Puente (Dunand) *"Transforming Gas-phase-alloyed, Ni-based Wires into Microtubes via the Kirkendall Effect"*

Hilliard Symposium organizer Yip-Wah Chung with speaker Carolyn Duran.

Justin Railsback (Barnett) *"Electrochemical Evolution of Solid Oxide Fuel Cell Oxygen Electrodes"*

Daniel Sauza (Seidman/Dunand) *"Microstructure and Mechanical Properties of γ'-strengthened Co-base Superalloys"*

Tejas Shastry (Hersam) *"Towards Stable Thin-film Solar Cells Using Carbon Nanotubes"*

Yu Jin Shin (Hersam) *"Centrifugal Sorting and Shape-dependent Response of Au Nanoparticles"*

FACULTY NEWS

Jiaxing Huang, **Yonggang Huang**, **Mercouri Kanatzidis**, **Tobin Marks**, **Chad Mirkin**, **John Rogers**, and **Samuel Stupp** were included in Elsevier Scopus Data's 2016 list of most cited researchers in MSE.

Zdeněk P. Bažant received the Austrian Cross of Honor for Science and Art, First Class.

Yonggang Huang will receive the 2017 William Prager Medal from the Society of Engineering Science. He also received the annual Cole-Higgins Award for Excellence in Teaching.

Mercouri Kanatzidis received the 2016 Samson-Prime Minister's Award for Innovation in Alternative Fuels for Transportation.

Lincoln Lauhon has been elected to the Materials Research Society's Board of Directors.

Tobin Marks will receive the 2017 Priestley Medal from American Chemical Society.

Chad Mirkin will receive the 2017 William H. Nichols Medal and the 2016 RUSNANOPRIZE.

Teri W. Odom was named to the 2016 class of American Chemical Society Fellows and 2016 Materials Research Society Fellows.

Monica Olvera de la Cruz will receive the 2017 Polymer Physics Prize from the American Physical Society.

Peter Voorhees was elected to the American Academy of Arts and Sciences.

STUDENT NEWS

Theo Gao (Hersam) received the Hilliard Award for Research and Design.

Norman Luu received the Hilliard Award for Leadership, Scholarship, and Service.

Jake Song was named Outstanding Junior.

Kyle Bushick was named Outstanding Sophomore.

Lawrence Crosby (L. Marks group) will receive the TMS Frank Crossley Diversity Award at the spring TMS meeting.

Allessandra Dicorato (Joester group) received a Chemistry of Life Processes Predoctoral Training Grant from the National Institutes of Health.

Meister Summer Research grants for 2016 were awarded to **Ryan Franks** (Luijten group) and **Binghao (Evan) Guo** (Dravid group).

Jaye Harada (Rondinelli group) received one of the first ACM SIGHPC/Intel Computational and Data Science fellowships.

Senior **Sarah Rappaport** placed third in the student speaking contest at MS&T 2016.

Kristen Scotti (Dunand) won the US and Canada region's 2016 Undergraduate Award in the math and physics category.

Professor Gregory Olson's students — **David Chae**, **Nate Gilbert**, **Yongwook Oh**, **Sara Rappaport**, **Christina Robinson**, and **Ryan Weidinger** — placed second in ASM Materials Education Foundation's 2016 Undergraduate Design Competition.

ALUMNI NEWS

Doreen Edwards (PhD '97, Mason) is now dean and professor of the Kate Gleason College of Engineering at the Rochester Institute of Technology.

Ganesh Jarayam (PhD '95, L. Marks) leads the Global Information Technology function for John Deere in Moline, Illinois.

Deep Jariwala (PhD '15, Hersam) received the 2017 Richard L. Greene Dissertation Award in Experimental Condensed Matter or Materials Physics from the American Physical Society.

Jiayan Luo (PhD '13, Huang), professor at Tiajin University in China, received the Nanocarbons Division SES Young Investigator Award from the Electrochemical Society.

Michele Manuel (PhD '07, Olson) was recently promoted to professor of materials science and engineering at the University of Florida.

Koichi Tsuchiya (PhD '91, J.R. Weertman) is now managing director of the Research Center for Structural Materials at National Institute for Materials Science in Japan.

The State University of New York Board of Trustees has appointed **Jinliu (Grace) Wang** (PhD '01, Chung) as vice chancellor of research and development at SUNY.

Northwestern | McCORMICK SCHOOL OF ENGINEERING
Materials Science and Engineering

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Blasting Off

NASA selected undergraduate Kristen Scotti's freeze-casting experiment to be launched into low-Earth orbit next year. Funded by NASA, the project will be held inside a CubeSat, a miniaturized satellite used for space research and education.

Advised by Professor David Dunand, Scotti is coordinating a team of students to design and build the freeze-casting instrumentation within the CubeSat and operate it.

The Northwestern team includes engineering students: Youwu Fang, Jared Burns, Matt Ocana, Joe Severini, Andy McIntosh, Erin Fillingham, Emily Northard, Lauren Kearney, Jonathan Young, Benjamin Richards, and Yang Xia.

Read more about the Department of Materials Science and Engineering's out-of-this-world research on page 3.